POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 41st cycle

Research Area n. 3 - Systems and Control

THEMATIC Research Field: ENHANCED VISUAL SERVOING MANIPULATION FOR INTELLIGENT SHARED AUTONOMY IN IOS SCENARIOS

Monthly net income of PhDscholarship (max 36 months)
1500.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	In-orbit servicing (IOS) is a key enabler of sustainable space exploration and commercialization. By supporting critical tasks such as refueling, repairing, upgrading, and redeploying satellites, IOS significantly extends spacecraft lifespans. As a result, developing robotic strategies capable of performing autonomous IOS operations is becoming a key priority in the space industry.Currently, most space manipulator systems rely heavily on teleoperation, which introduces challenges such as communication latency and the need for highly skilled operators. These limitations hinder real-time manipulation and responsiveness. To overcome these challenges, shared autonomy offers a promising solution by combining the strengths of human intuition and oversight with the speed and precision of autonomous systems. Intelligent robotic agents capable of local decision-making and collaborative control are therefore essential for the success of future IOS missions.Among the enabling technologies, visual servoing is a crucial control strategy that leverages visual feedback to allow robotic systems to perform complex maneuvers such as approaching, grasping, and manipulating objects with the accuracy required for IOS tasks. This PhD thesis aims to develop visuomotor skills through advanced visual servoing strategies, enabling reactive and adaptable motion control

	based on visual input. These skills are fundamental for robust IOS scenarios to identify, approach, and track targets, and mitigate contact effects while compensating for environmental uncertainties and disturbances scenarios.
Methods and techniques that will be developed and used to carry out the research	The research will explore classical approaches such as Position-Based Visual Servoing (PBVS) and Image-Based Visual Servoing (IBVS), as well as hybrid methods tailored to the specific requirements of IOS missions. Crucially, these strategies will be designed to function within a shared autonomy paradigm, where the system can dynamically adapt its level of autonomy based on operator input, confidence in perception, and mission constraints. Methodologies will be designed and developed considering several challenges linked to the space environment such as: - Change of lighting conditions - Highly reflective or texture-less target surfaces - Uncertainty in target motion, which may be static, drifting, or tumbling Special focus will be placed on developing techniques to estimate the target's motion state, allowing for dynamic tracking and prediction.The methodologies developed in this thesis will be validated through both simulations and real-world experiments in representative test environments, with an emphasis on evaluating the performance and robustness of the shared autonomy approach in diverse IOS The research is in the framework of a joint agreement with Leonardo Robotics Lab (Italy) and will be conducted at Politecnico di Milano (Merlin and Nearlab, DEIB) and at the Leonardo premises in Genova (Italy).The candidate is expected to spend one year at the Leonardo premises in Genova.
Educational objectives	- Acquire capabilities for effectively controlling robots with visual information; - Understanding the task needs and evaluate the effectiveness of the approach; - Disseminate scientific results in journals/ conferences;

	- Communicate scientific results in outreach events.
Job opportunities	Research institutes/centres; research division in companies; universities; technology transfer offices.
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 10 PhD Students
Name of the research directors	Paolo Rocco, Elena De Momi, Andrea M. Zanchettin

Contacts

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student.
There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

COMPUTER AVAILABILITY:
1st year: Yes
2nd year: Yes
3rd year: Yes